Environmental regulation of puberty in salmon
(and smolting)

**Brian Beckman, Don Larsen, Paul Parkins, Deb Harstad,
Dina Spangenberg and Penny Swanson
NOAA Fisheries and SAFS University of Washington**

Goals:

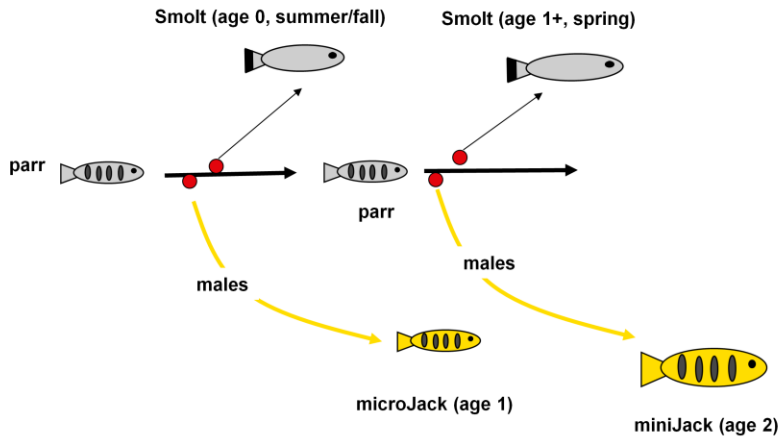
Illustrate juvenile life history variability within one population

(Yakima River Spring Chinook salmon)

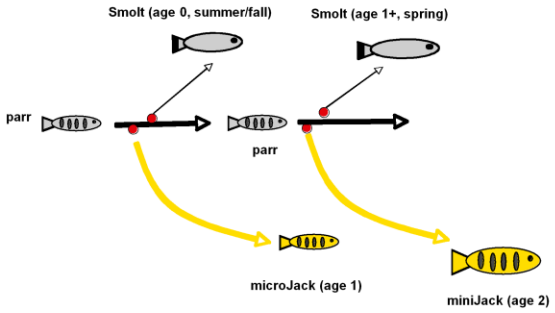
Discuss implications for variation in returning hatchery adults

Discuss implications for domestication selection

Transition points in the early life history of Chinook salmon



Goal: conduct experiment that induces the full range of life history variants



Outline

- Describe experiment
- Describe results
  - smolting
  - early male maturation
- Discussion and implications

Inspiration for the experiment

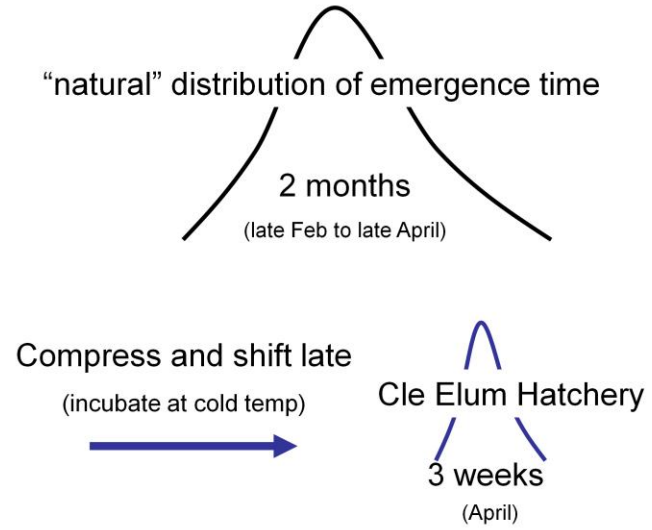
10 years of sampling, >12,000 fish
= 2 microJacks (age 1)
= < 0.02%

Why so few microJacks?

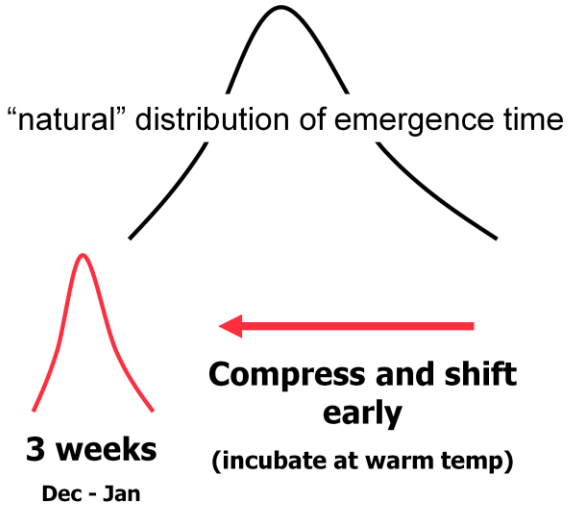
(would expect 5 - 10%, 300 - 600 males*)

*** not sampling error**

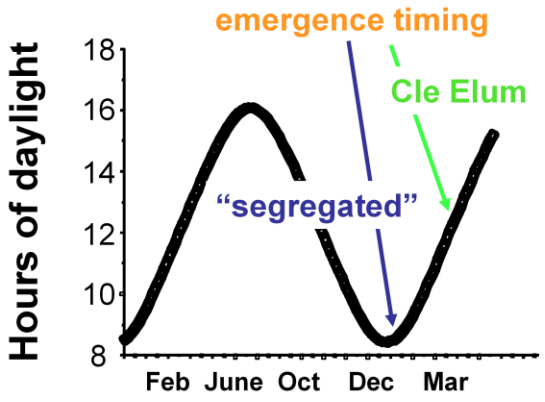
At Cle Elum Hatchery
Fry ponding shifted "late"- avoid silting of ponds, smaller size at release



"Segregated" hatcheries may alter emergence (ponding)
Pond "early" - longer growth period, clear egg stacks



Photoperiod at emergence differs among hatcheries



Hypothesis:

life history variation may be induced by manipulating emergence timing and associated photoperiod at emergence

Experimental Question:

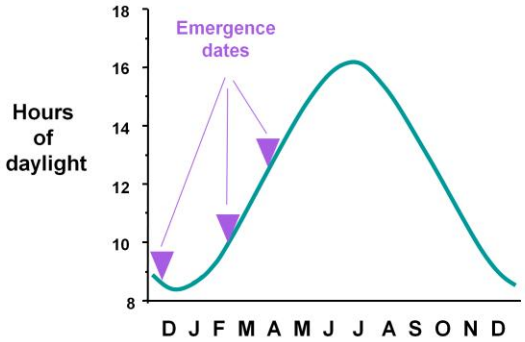
What is the effect of emergence timing on life-history decisions?

Experimental approach:

Pond fry at 3 different photoperiods

1 December (early)
15 February (middle)
1 May (late)

Experimental emergence (ponding) times spanned range from aggressive hatchery program to coldest, high elevation sites



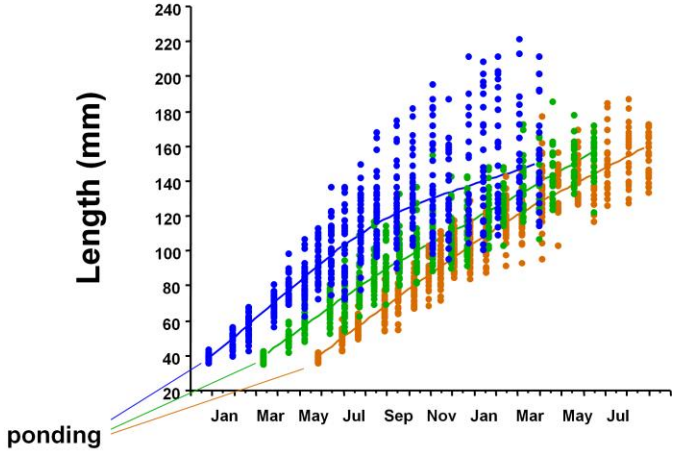
Growth rate also important determinant of smolting and maturation in spring Chinook salmon (numerous studies)

Experimental approach II:

feed fry at 3 different rates

Low
High
Satiation

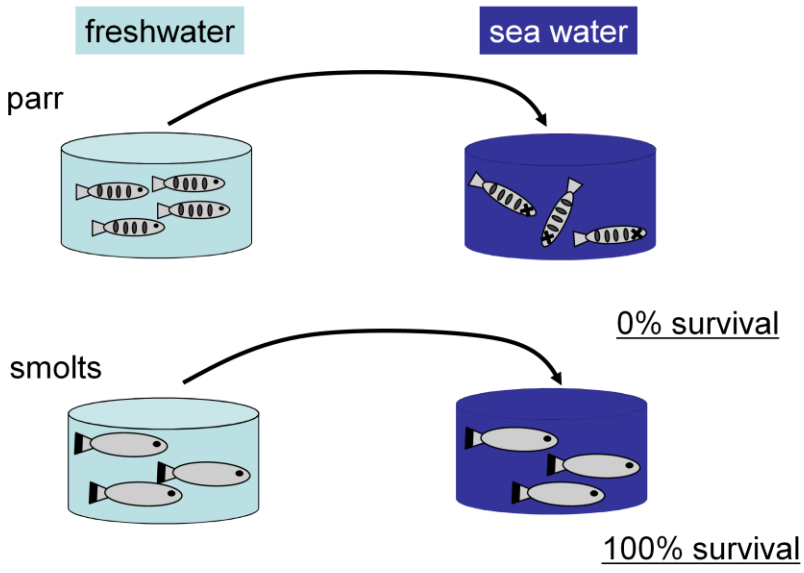
Emergence and growth of fish varied



Thanks to Charlie Strom and CESRF staff for eggs

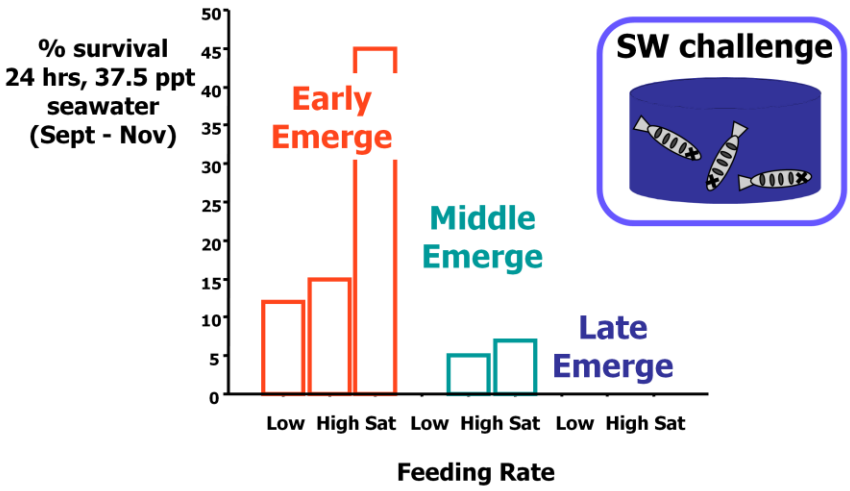
Monitoring Smolting:

24 hr seawater challenge

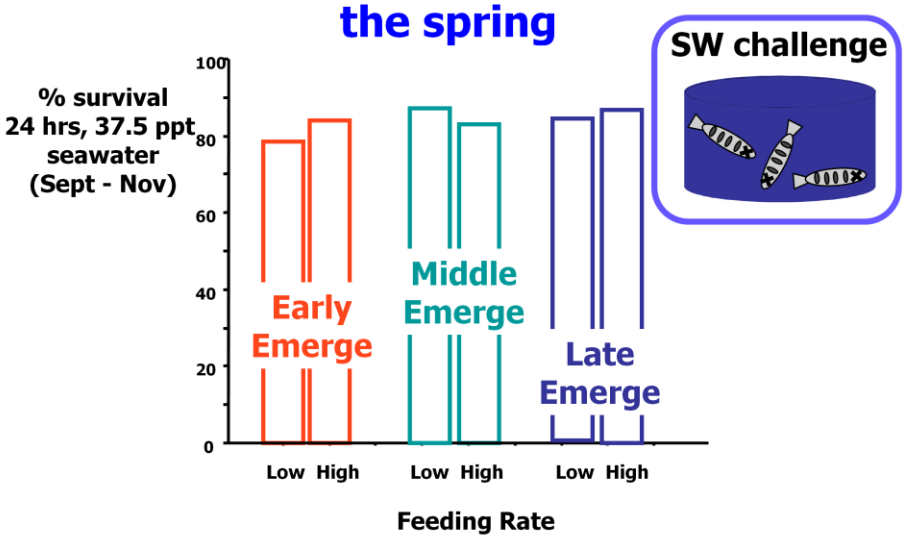


Are smolting patterns different among treatments?

Some early emerging fish smolt in the autumn no later emerging fish do



All groups smolted as yearlings in the spring



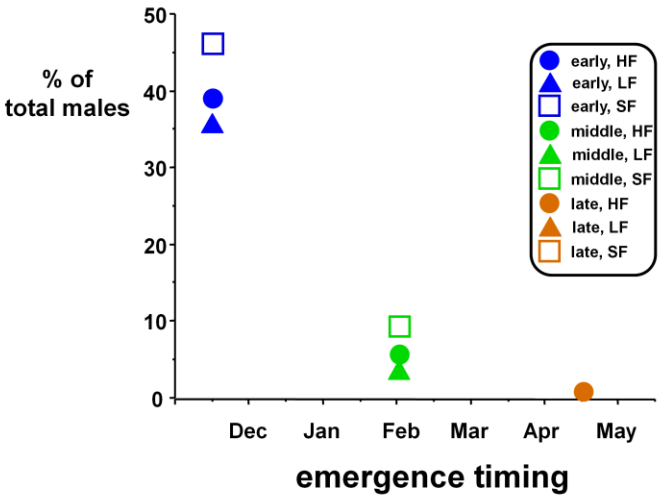
early emergence promoted under-yearling (age 0) smolting in spring Chinook salmon

⇒age of smolting may be variable, even in spring Chinook salmon.

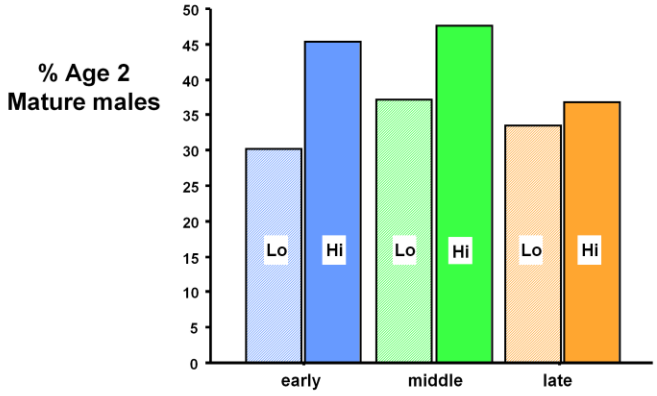
Do male maturation patterns differ?


Male maturation was simply assessed by visual inspection of the testis
57

Proportion of microJacks (age 1) varies negatively with emergence timing



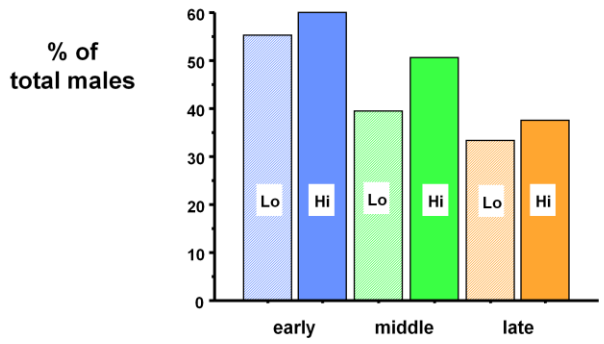
Propensity of an immature individual to mature at age 2 does not differ among emergence timing => Propensity to mature as a miniJack dependent on growth the year previous



No significant differences between emergence times

HiFeed > LoFeed, $p < 0.05$

Total mature males (micro + mini) is higher in early emerging fish
Overall ranged from 35 - 60%



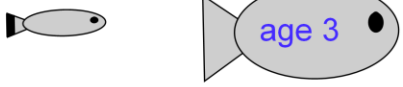
Implications 1). variation in smolting

Deliberate splitting of production releases into under-yearling and yearling releases:

Snake River Fall Chinook salmon
Upper Columbia Summer Chinook salmon

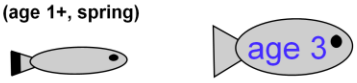
If fish return @ same age (3) => Size Varies

Smolt (age 0, summer/fall)



2.0 years ocean rearing

Smolt (age 1+, spring)

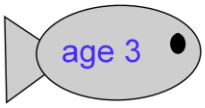


1.5 years ocean rearing

Can fish return @ same size?

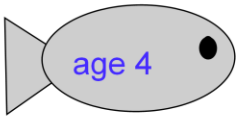
⇒**Age Varies**
(and size might too)

Smolt (age 0, summer/fall)



2.0 years ocean rearing

Smolt (age 1+, spring)

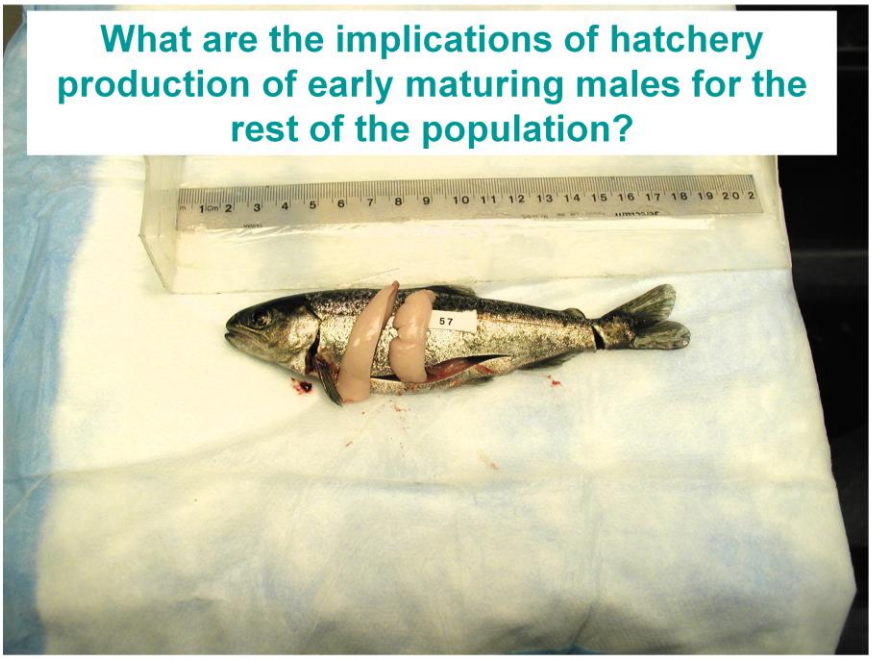


2.5 years ocean rearing

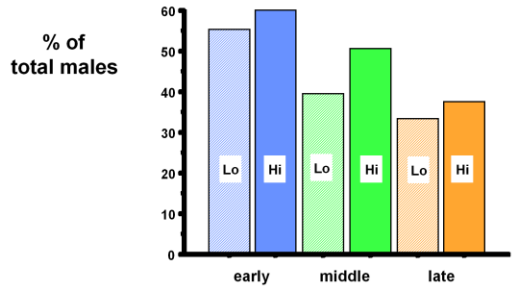
Varying age of smolt release will inevitably result in variation in age and size of returning adults

=>>> Correct proportion of age 0 and age 1 smolts in summer and fall Chinook salmon production programs to mimic age/size of adult return in wild populations?

What are the implications of hatchery production of early maturing males for the rest of the population?

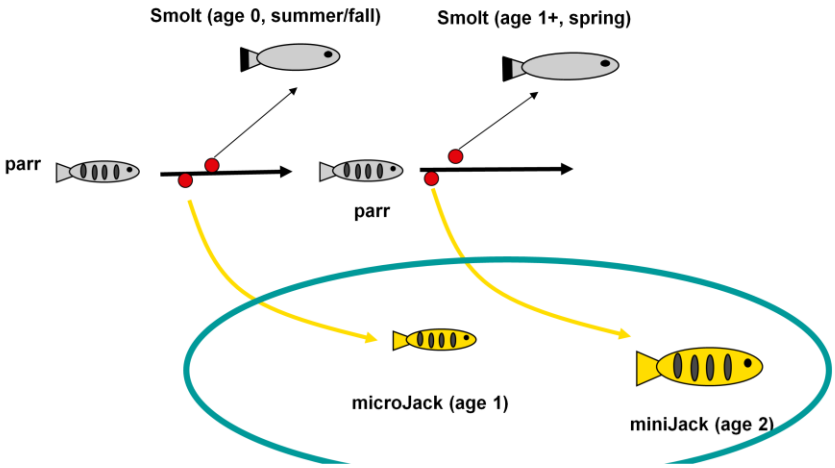


If hatcheries produce a large proportion of early maturing males(see Don's talk next), does that alter the relative size/age of the remaining returning "adults"?



35 - 60% of males in experimental population

Does anyone use early maturing males in their hatchery spawning protocols?



35 - 60% of males in experimental population

A significant portion of males may be SELECTIVELY removed from spawning populations of hatchery fish

(fast-growing males)

= domestication?

Conclusions:

Environmental variability during juvenile rearing has the potential to significantly alter juvenile life history trajectories.

And, these alterations may have important implications for the age and size of return of "adult" Chinook salmon.

=> See Don's talk (up next) for the realities of hatchery production of early maturing males.